DIMENSIONS NBS

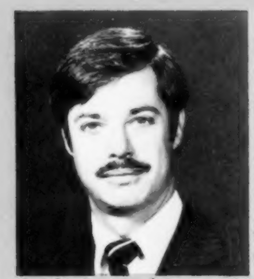
The magazine of the
National Bureau
of Standards
U.S. Department
of Commerce

July/August 1979

A NEW SATELLITE SYSTEM. See page 13.

COMMENT

FIRE RESEARCH



We at the National Bureau of Standards Center for Fire Research may be a bit biased, but we think we are unusually lucky. Our field has room for contributions ranging all the way from the most fundamental science to the last word on engineering design. The results of our research have direct application to saving lives, so we are as interested in seeing our work used as we are in doing it.

Yet all of us are frequently reminded that there is no such thing as absolute safety. For example, in setting safety code requirements for buildings, public officials must balance a desire to provide the safest possible environment with the need for functional and economical construction. Nowhere is this balance more delicate than in hospitals and nursing homes. Immobile and infirm patients require a high level of fire protection while, at the same time, construction costs are an important contributor to the already high cost of health care. The better our understanding of the fire safety needs of these occupancies, the more likely they can be met at reasonable cost. Thus, we in the Fire Center are particularly pleased to have developed the Fire Safety Evaluation System for health care facilities, which is the subject of this month's DIMENSIONS article (See page 4).

The system is designed to address, for one kind of occupancy, a general problem in fire safety. The problem springs from the fact that many fire protection measures have been required by building codes for a number of years, but a detailed understanding of building-fire behavior is only now being developed. Codes have done a good job of protecting the public. But as our knowledge of fire has increased, we sometimes discover that equivalent protection can be obtained by measures which are more flexible, or less expensive, than those originally required by the code. Code enforcement officials have traditionally lacked a systematic means for evaluating the equivalence of protective measures. Providing such a tool is not simply a technical nicety, it can remove real barriers, especially to building rehabilitation. How readily an existing building can be "brought up to code" may determine whether it becomes a community asset or remains a troublesome derelict.

Fire is only one area of concern; the problem has analogs in many other aspects of building science. Working with our colleagues in the Center for Building Technology, another unit of the National Engineering Laboratory, we hope to continue what has become a broadly based effort to bring new and improved technology to bear on the Nation's building regulatory system.

Frederic B. Clarke
Director, Center for Fire Research
National Bureau of Standards
Polymers Building A247
301/921-3143

DIMENSIONS NBS

The magazine of the
National Bureau of Standards
U.S. Department of Commerce
Volume 63/Number 7/8

July/August 1979

Contents

ARTICLES

INTERFACE

UPDATE


COMMON SENSE APPROACH TO
METRIC CONVERSION

Over the past several years, DIMENSIONS/NBS has carried a number of articles concerning metric conversion. They have been published as part of an informal service provided by the National Bureau of Standards to promote public awareness in this area. Now there is an official focal point within the Federal Government concerned with metric conversion: The U.S. Metric Board. The following is, therefore, the last general-interest article on metric planned for publication in this magazine. DIMENSIONS readers are urged to address general inquiries concerning conversion to: United States Metric Board, 1815 N. Lynn Street, Arlington, VA 22209.

The National Bureau of Standards remains responsible for maintaining the legal system of measurement units for this Nation. DIMENSIONS will continue to publish technically oriented reports on the International System of Units (SI).

---

by Jeff Odom

One basic reservation about metric conversion is a concern about the cost of changing over. Many people feel that all of our tools, school books, even our food recipes will be converted, and at a considerable expense. The good news is that although many of these items —and more—will eventually become "metric," the associated costs can be greatly reduced, if not eliminated, by the application of the rule of reason.

Simply stated, this rule is merely common sense, a commodity that needs to be liberally applied as we go metric. To the extent that common sense is followed, costs will be of little concern. Let me illustrate with these examples:

At Home

In the kitchen, we will not adopt the European practice of weighing ingredients. Rather, we will continue to measure by volume, using measuring cups and spoons. And when new metric recipes appear, we will be able to use them with the aid of measuring utensils graduated in both ounces and metric units. (Actually, if you have purchased a new measuring cup recently, it probably has both graduations.) With these devices, you can go right on using your old, familiar recipes. There is no need to buy new cookbooks—much less a scale.

Around the house, you have measuring equipment or devices such as the thermostat for your furnace or the heat control on your oven. You may some day decide to replace these to read directly in metric, but you may prefer to avoid that expense by using a conversion chart. You could even tape the chart to the existing device for quick reference on those occasions when conversion is necessary.

You may also own socket wrenches and other non-adjustable tools. Some addition of metric devices will be required, but the cost can be kept to a minimum by adding only what is absolutely necessary. In the case of the socket wrenches, for example, only the sockets need be replaced—not the handles, drives, and so on. Don't forget that most tools—hammers, saws, levels, and the like—won't need to be replaced.

Land titles will one day be recorded in metric, but as dictated by the rule of reason, this change will apply only to newly surveyed land. The expense and trouble of revising existing documents would not be worth the effort.

In Education

School books will, of course, have to change. If this were done over a short period of time, the cost would be enormous. Fortunately, an application of the rule of reason will essentially eliminate this expense: Nearly all textbooks are replaced every four or five years; as long as we have the time to properly plan the changes (and we do have the time), new metric books can be phased in during normal replacement. Since metric texts cost no more than their inch-pound counterparts, there is no added expense.

In Industry

Industry in the United States has been the leader in the move to metric as well as a leader in the application of the rule of reason. As most companies have decided to go metric, they have resisted the idea of suddenly revising all of their manufacturing operations. Rather, they have opted for the more gradual process of designing all *new* items to metric sizes. This means that the changeover might take five, even ten years. It also means that the expenses are limited to how much *more* it costs to design and produce any given item in metric as compared to inch-pound. In most experiences to date, this amount has been nearly zero.

Many machine tools used in the manufacturing process have measuring capabilities. Many people have felt that these machines would need to be replaced. A careful application of the rule of reason has led to the realization that only the scale or the dial that makes or indicates the measurement needs to be changed, frequently at a small fraction of the cost of replacing the machine itself.

Costs in all areas can be minimized with careful planning and common sense. There is, however, one obvious question related to expense and metric conversion: "What will the total price be?" Unfortunately, that cannot be determined, in part because as we proceed along the pathway to metric, we will undoubtedly, using our American ingenuity, find new applications of the rule of reason, new ways to avoid costs. Whatever the costs, they should not be incurred unless they are compensated by benefits. □

Odom is metric coordinator for the National Bureau of Standards.

FIRE SAFETY FOR HEALTH CARE FACILITIES:

CUTTING COSTS WITHOUT CUTTING CORNERS

by Mat Heyman

The Department of Health, Education, and Welfare believes that a new tool developed by the National Bureau of Standards can help health care facilities across the country save about one-half the amount they would otherwise have to spend to bring their buildings up to presently required levels of fire safety. Over a period of years, this could add up to as much as a billion dollars.

The Veterans Administration estimates that the same NBS innovation can help its hospitals forego several hundred million dollars in similar expenses over the next five years—slicing that agency's expected building modification costs by nearly 50 percent.

And neither organization will be sacrificing anything in terms of fire protection for the occupants of these buildings. In fact, by getting increased safety for each dollar spent, they will be able to speed the pace at which buildings are brought up to accepted levels.

Known as the Fire Safety Evaluation System (FSES), the Bureau's new tool is a unique analytical technique for evaluating the level of fire protection in buildings. It offers a way to compare—in terms of fire safety and cost—the alternatives for refitting a building or designing a new one, so that the level of safety would satisfy the National Fire Protection Association's widely used 1973 Life Safety Code. In short, the NBS system can identify the most economical means of meeting the code's requirements from among thousands of options.*

Heyman is a writer and public information specialist in the NBS Public Information Division.

The FSES was developed by the Bureau's Center for Fire Research with the support of the Department of Health, Education, and Welfare (HEW) as part of a five-year NBS-HEW cooperative program addressing fire safety. Also, the NBS Center for Building Technology and the Center for Applied Mathematics have contributed to the FSES work.

The Life Safety Code provides fixed requirements for fire safety in designated types of structures, but it also allows solutions that are "equivalent" from a safety standpoint. However, the code defines only a few alternatives and does not provide a means of determining equivalence. For health care institutions with sleeping facilities, the Bureau's FSES can help generate and lend credence to safe alternatives by supplying the mechanism for assessing such equivalence.

The FSES represents a performance-oriented approach to fire safety in these facilities in place of the fixed requirements in the Life Safety Code. For example, the code specifies that every floor of a hospital must contain doors and partitions that have been tested for fire resistance and that it must have interior walls with a particular rating for flame-

** A complete description of the FSES and related worksheets are included in* A System for Fire Safety Evaluation of Health Care Facilities *(NBSIR 78-1555) by Harold E. Nelson and A. Jeffrey Shibe. Copies are available for $7.50 from the National Technical Information Service, Springfield, VA 22151. Order by #PB 292 273.*

spread characteristics. In these cases, the code mandates that doors, partitions, and walls must measure up to the specific requirements. With FSES, one can analyze whether other combinations of devices—such as smoke detectors and sprinklers—could provide the same level of protection at a lower cost.

Similarly, a hospital with several dead-end corridors—a characteristic that would normally mean the building was not in compliance with the NFPA code—might be able to offset this negative factor by adding one or more features not required under the code but which would be less costly than extensive renovation.

The FSES works by giving appropriate credit to those features that are in excess of the minimum safety requirements in the Life Safety Code. Conversely, features that increase the fire risk to occupants are charged for their detrimental effects.

While it has long been theorized that such an evaluation system was possible, the FSES for the first time presents a systematic means for establishing fire-safety equivalence. It can provide the guidance needed by building designers, redesigners, and managers as well as by health care and building regulatory authorities responsible for assuring the public of fire safe facilities.

Harold E. Nelson, who heads the Design Concepts Research in the NBS Center for Fire Research, and co-worker A. Jeffrey Shibe did most of the developmental work on the system.* They have high hopes that the techniques will be a major step forward in the evolution toward more flexible, innovative, and economical remedies for the fire safety problems of health care facilities. Nelson says, "We see the evaluation system as a reasonable step for moving from the existing prescriptive code approaches toward the performance approach. But it is no panacea. It is an advance and more can be done."

** Irwin A. Benjamin and Harry Shoub of NBS originally did early conceptual work on the system several years ago.*

turn page

The NBS-developed Fire Safety Evaluation System can be applied to a range of health care facilities—from the small nursing home to the larger hospitals across the country.

How the System Works

Basically, the FSES can be used to evaluate the elements of risk and types of construction in specific health care facilities by assigning relative numerical values to each factor. An individual analysis is performed for each fire/smoke zone in a building. (The fire/smoke zone is defined as a space separated from all other spaces by floors and by horizontal exits—such as fire proofed pass-through to another wing—or smoke barriers. For instance, one zone might include one hospital ward. Where a floor is not subdivided by horizontal exits or smoke barriers, the entire floor becomes the zone.)

Three major factors are taken into account by the FSES: risks to occupants, the capacity of the building and its fire protection systems to provide safety commensurate with that risk, and the redundant safety capabilities available to ensure safety in case any single safeguard fails. The calculated occupancy risk level provides a minimum target for which levels of protection must be provided by the nature of the building design, supplemented by appropriate passive and active fire protection devices—for instance, fire doors and sprinklers.

The computer program permits the evaluator to review all possible solutions to the problem with assurance that the answers will not be biased by individual preferences.

The occupancy risk is gauged by the number of people who will be affected by a given fire, the kind of fire they are likely to encounter, and their ability to protect themselves. Specifically, the system requires information on patient mobility, patient density, location within the building (for example, in the basement or on upper levels), ratio of patients to attendants, and average age of patients. (See Tables 1 and 2.) These individual occupancy risk factors are given numerical values and adjusted to reflect the type of building being considered and whether it is new or old. (The Life Safety Code permits less stringent safety requirements for existing buildings owing to the technical problems and costs associated with upgrading those structures, which in many cases could be prohibitive. See Table 3.)

The next step in the evaluation involves an assessment of the ability of the building zone and its fire protection system to provide measures of safety commensurate with the calculated occupancy risk. This analysis addresses the general safety of the zone and three separate safety "subsystems."

The FSES safety evaluation includes a weighting of 13 individual safety factors (Table 4). These cover everything from the type of construction involved (wood frame or noncombustible materials, for example) and the assessed fire rating of the interior finish of rooms and corridors to the number of emergency routes available and the presence of manual fire alarms, smoke detectors, and automatic sprinklers. This section of the analysis offers a way to judge the overall level of safety in the fire/smoke zone.

It also permits an evaluation of three separate safety subsystems related to fire containment, the ease and speed of extinguishment, and the movement of people within the zone (Table 5). For instance, a rating for extinguishment safety is arrived at by combining information about the number of hazardous areas, and the existence or absence of fire alarms, smoke detectors, and sprinklers. (Fire zones with few hazardous areas and with detectors, alarms, and sprinklers would naturally score high for extinguishment safety.) By analyzing the zone for each of the subsystems, the FSES provides insight into the structure's "safety redundancy," an important feature should a single protective device not function as expected.

Fire/smoke zone safety requirements for containment, extinguishment, and movement of people are set out by the FSES. These minimum safety levels—which are equal to the protection provided by strict compliance to the Life Safety Code—are then used as the basis for comparing the safety of the existing or contemplated structure with the level inherent in the code.

In order to measure up to the code, the zone's rating for each of the three subsystems must match or exceed each of the levels set out in the mandatory safety requirements table. Moreover, the general rating (computed from individual evaluations of

the 13 safety elements) must be greater than the calculated occupancy risk.

In order to make it easier to apply the FSES system and to analyze potential changes, Bureau researchers have developed a special computer program. Using only the basic worksheets of the FSES, an experienced engineer can manually analyze 10 to 15 different systems in a fire/smoke zone and make a suitable selection. The computer program permits the evaluator to review all possible solutions to the problem—there are about 172 million combinations of the 13 safety factors and variations —and be assured that the answers will not be biased by individual preferences. (For practical purposes, the computer program will highlight a few hundred of the most promising options rather than the several million possible design alternatives for a building.) The printouts of the possible zone arrangements can be readily analyzed to determine equivalent solutions.

A companion computer program recently developed by researchers in the NBS Center for Building Technology and the Center for Applied Mathematics demonstrates a capability to estimate the relative cost of the various fire safety alternatives, thereby allowing facility evaluators or designers of new buildings to rank the alternate systems in terms of cost.* The program thus can provide a list of the top fire protection choices available at the lowest cost. Other factors such as aesthetics, schedules, and interruption of operations may also be considered in making the final choice.

Judgment a Key Factor

While the format for collecting and analyzing information about a building's fire safety systems is different and some new but easily gathered data about occupant risk is required, building evaluators and designers still must pass judgment on the adequacy of individual safety elements. For instance, in order to complete the worksheet rating the 13 safety factors (Table 4), the evaluator must decide into which class a zone's corridor doors fit: Will they last 20 minutes in a fire or will they hold up longer? Are the corridor ceiling tiles rated as a "Class C" material or a better flame-spread rating of "Class A?" In short, good engineering judgment is still a mandatory requirement for either approach—the traditional Life Safety Code analysis or the FSES.

"The nationwide implications of this new system are dramatic," says HEW Secretary Joseph A. Califano.

Professional engineering judgment has already played a big part in FSES development. Since relative values have been assigned to each of the elements of risk and types of construction in the building, the professional viewpoints of those who crafted the system are vitally important. To make sure these points of view are in agreement with those held by experts, NBS established a thorough review process involving Bureau personnel and knowledgeable outside individuals and groups.

In the initial work on the system, NBS researchers detailed the fire safety elements in the Life Safety Code and organized the proposed FSES into a workable format that could be related to the code's requirements. Bureau fire protection engineers and researchers then gave each element its weighting to reflect relative importance in terms of fire risk and safety. The individual valuations were based on experience in the fire safety field coupled with NBS fire research results and data from the Bureau's investigation of fires in health care facilities.

Once the values were assigned, a panel of recognized specialists—including designers, enforcement authorities, and others—was called upon to review and critique the FSES particulars, improving both the

turn page

* Economic Aspects of Fire Safety in Health Care Facilities: Guidelines for Cost-Effective Retrofits, *contact Robert Chapman, A319 Building Research Building, 301/921-2278.*

format and the final values. Representatives of the National Fire Protection Association's Committee on Safety to Life were kept abreast of progress. That committee established its own group of experts who further critiqued the system and provided advice about bringing FSES into conformance with Life Safety Code terminology.

Once the system had been developed, NBS carried out a series of field tests and simulations on individual facilities to check out its practicality and usefulness. These test cases enabled NBS researchers to compare the types of safety alternatives that met the FSES requirements with those prescribed in the Life Safety Code.

What FSES Does Not Do

The technique designed by NBS has certain limitations. First of all, its application is currently limited to health care facilities because the weighted values have been tailored specifically for the needs of those institutions. Provided appropriate values are assigned, the system could work for other types of buildings. Also, the system does not evaluate absolute fire safety but only that relative to a given code.

Next, the numbers assigned to each of the elements or components do not presently provide any leeway to reflect credit for in-place but only partially effective safety features. For example, if a door is louvered to provide better ventilation, it cannot be counted as a door because it permits smoke to enter or escape a patient's room. Additional developmental work on the system could result in a way to assign partial values for individual elements.

Finally, the system provides no mechanism for taking into account alternative approaches for specific Life Safety Code requirements outside the building-frame requirements, such as utilities, furnishings, or administrative activities (for example, emergency plans and fire drills). Instead, a simple checklist is attached to the FSES worksheets, allowing for a separate, traditional type of evaluation for these features.

A Future for the System

Additional research and experience will provide the kind of information that may help overcome some of the present limitations of the FSES. However, even without improvement, the FSES is clearly viewed as a very useful tool.

HEW Secretary Joseph A. Califano strongly endorsed the Bureau's accomplishment in a speech earlier this year, noting that his Department's Health Care Financing Administration is in the process of adopting the system for use by all hospitals receiving Medicare and Medicaid funds. Pointing out the potential for helping to reduce the Nation's spiraling health care costs, Califano cited his agency's estimate of a $1 billion savings through use of the FSES and declared, "The nationwide implications of this new system are dramatic."

NBS staffers already have been working with HEW to explain the FSES to officials in charge of fire safety in hospitals and other health care facilities. As part of this effort, HEW regional officials have twice visited the Bureau for workshops on the system, including a test evaluation of a Washington, D.C., Veterans Administration hospital. The U.S. Fire Administration is developing a training package to help HEW implement the system.

Meanwhile, the VA itself is pleased with its experience with the FSES. Mike Slifka, chief of Safety, Occupational Health, and Fire Protection for the agency, says, "It gives the most cost-effective means of doing the job," with actual cost-savings to date ranging from 30 to 80 percent as compared with previously estimated costs for bringing facilities into compliance with the Life Safety Code.

Right now, NBS has proposed that the FSES be formally incorporated in the upcoming 1980 revision of the Life Safety Code. The system has been under consideration by the National Fire Protection Association's Committee on Safety to Life.

Meanwhile, at the request of several other agencies, Bureau researchers are studying the possibility of applying the FSES to other types of buildings, including group homes for the developmentally disabled (HEW), existing multifamily residences (Department of Housing and Urban Development), and prison housing (Law Enforcement Assistance Administration). These agencies have asked NBS for help in taking advantage of the promise that FSES holds for cutting fire safety costs—without cutting corners. □

FIRE/SMOKE ZONE* EVALUATION WORK SHEET FOR HEALTH CARE FACILITIES

FACILITY______________________________ BUILDING____________________________

ZONE(S) EVALUATED____

EVALUATOR______________________________ DATE____________________________

Complete this work sheet for each zone. Where conditions are the same in several zones, one work sheet can be used for those zones.

Step 1: Determine Occupancy Risk Parameter Factors - Use Table 1.

A. For each Risk Parameter in Table 1, select and circle the appropriate risk factor value. Choose only one for each of the five Risk Parameters.

Table 1. OCCUPANCY RISK PARAMETER FACTORS

RISK PARAMETERS	RISK FACTOR VALUES					
1. PATIENT MOBILITY (M)	MOBILITY STATUS	MOBILE	LIMITED MOBILITY	NOT MOBILE	NOT MOVABLE	
	RISK FACTOR	1.0	1.6	3.2	4.5	
2. PATIENT DENSITY (D)	PATIENT	1-5	6-10	11-30	>30	
	RISK FACTOR	1.0	1.2	1.5	2.0	
3. ZONE LOCATION (L)	FLOOR	1ST	2ND OR 3RD	4TH TO 6TH	7TH AND ABOVE	BASEMENTS
	RISK FACTOR	1.1	1.2	1.4	1.6	1.6
4. RATIO OF PATIENTS TO ATTENDANTS (T)	PATIENTS	1-2	3-5	6-10	>11	ONE OR* MORE
	ATTENDANT	1	1	1	1	NONE
	RISK FACTOR	1.0	1.1	1.2	1.5	4.0
5. PATIENT AVERAGE AGE (A)	AGE	UNDER 65 YEARS AND OVER 1 YEAR		65 YEARS & OVER 1 YEAR & YOUNGER		
	RISK FACTOR	1.0		1.2		

* RISK FACTOR OF 4.0 IS CHARGED TO ANY ZONE THAT HOUSES PATIENTS WITHOUT ANY STAFF IN IMMEDIATE ATTENDANCE

Step 2: Compute Occupancy Risk Factor (F) - Use Table 2.

A. Transfer the circled risk factor values from Table 1 to the corresponding blocks in Table 2.

B. Compute F by multiplying the risk factor values as indicated in Table 2.

Table 2. OCCUPANCY RISK FACTOR CALCULATION

	M		D		L		T		A		F
OCCUPANCY RISK	☐	×	☐	×	☐	×	☐	×	☐	=	☐

Step 3: Compute Adjusted Building Status (R) - Use Table 3A or 3B.

A. If building is classified as NEW use Table 3A. If building is classified as existing use Table 3B.

B. Transfer the value of F from Table 2 to Table 3A or Table 3B as appropriate. Calculate "R."

C. Transfer "R" to the block labeled "R" in Table 7 on page 4 of the work sheet.

Table 3A. (NEW BUILDINGS)

	F		R
1.0 x	☐	=	☐

Table 3B. (EXISTING BUILDINGS)

	F		R
0.5 x	☐	=	☐

*FIRE/SMOKE ZONE is a space separated from all other spaces by floors, horizontal exits, or smoke barriers.

Step 4: Determine Safety Parameter Values - Use Table 4.

A. Select and circle the safety value for each safety parameter in Table 4 that best describes the conditions in the zone. Choose only one value for each of the 13 parameters. If two or more appear to apply choose the one with the lowest print value.

Table 4. SAFETY PARAMETERS VALUES

PARAMETERS	PARAMETERS VALUES						
1. CONSTRUCTION		COMBUSTIBLE				NON-COMBUSTIBLE	
		WOOD FRAME		ORDINARY			
FLOOR OF ZONE		UNPROTECTED	PROTECTED	UNPROTECTED	PROTECTED	UNPROTECTED	PROTECTED	FIRE RESIST.
	FIRST	−2	0	−2	0	0	2	2
	SECOND	−7	−2	−4	−2	−2	2	4
	THIRD	−9	−7	−9	−7	−7	2	4
	4TH & ABOVE	−13	−7	−13	−7	−9	−7	4

PARAMETERS	PARAMETERS VALUES				
2. INTERIOR FINISH (Corr. & Exit)	CLASS C	CLASS B	CLASS A		
	−5	0	3		
3. INTERIOR FINISH (Rooms)	CLASS C	CLASS B	CLASS A		
	−3	1	3		
4. CORRIDOR PARTITIONS/WALLS	NONE OR INCOMPLETE	<1/3 HR	≥1/3 <1.0 HR	≥1.0 HR	
	−10 (0)*	0	1 (0)*	2 (0)*	
5. DOORS TO CORRIDOR	NO DOOR	<20 MIN FR	≥20 MIN. FR	≥20 MIN. FR & AUTO CLOS	
	−10	0	1 (0)***	2 (0)***	
6. ZONE DIMENSIONS	DEAD END MORE THAN 100'	DEAD END 30'–100'	NO DEAD ENDS >30' & ZONE LENGTH IS:		
			>150'	100'–150'	<100'
	−6 (0)**	−4 (0)**	−2	0	1
7. VERTICAL OPENINGS	OPEN 4 OR MORE FLOORS	OPEN 2 OR 3 FLOORS	ENCLOSED WITH INDICATED FIRE RESIST.		
			<1 HR	≥1HR <2 HR	≥2 HR
	−14	−10	0	2 (0)*	3 (0)*
8. HAZARDOUS AREAS	DOUBLE DEFICIENCY		SINGLE DEFICIENCY		NO DEFICIENCIES
	IN ZONE	OUTSIDE ZONE	IN ZONE	IN ADJACENT ZONE	
	−11	−5	−6	−2	0
9. SMOKE CONTROL	NO CONTROL	SMOKE PARTITION	MECH. ASSISTED SYSTEMS		
			BY ZONE	BY CORRIDOR	
	−2 (0)***	0	3	4	
10. EMERGENCY MOVEMENT ROUTES	<2 ROUTES	MULTIPLE ROUTES			
		DEFICIENT CAPACITY	W/O HORIZONTAL EXIT(s)	HORIZONTAL EXIT(s)	DIRECT EXIT(s)
	−8	−2	0	3	5
11. MANUAL FIRE ALARM	NO MANUAL FIRE ALARM		MANUAL FIRE ALARM		
			W/O F.D. CONN.	W/F.D. CONN.	
	−4		1	2	
12. SMOKE DETECTION & ALARM	NONE	CORRIDOR ONLY	ROOMS ONLY	CORRIDOR & HABIT. SPACE	TOTAL SPACE
	0	2	3	4	5
13. AUTOMATIC SPRINKLERS	NONE	CORRIDOR	CORRIDOR & HABIT. SPACE	TOTAL SPACE	
	0	2 (0)**	8	10	

NOTE: *Use (0) when item 5 is −10.

**Use (0) when item 10 is −8

***Use (0) in zone with less than 31 patients in existing buildings.

*Use (0) when item 1 is based on first floor zone or on an unprotected type of construction.

**Use (0) when item 1 is based on an unprotected type of construction.

***Use (0) when item 4 is −10.

Step 5: Compute Individual Safety Evaluations - Use Table 5.

A. Transfer each of the 13 circled Safety Parameter Values from Table 4 to every unshaded block in the line with the corresponding Safety Parameter in Table 5. For Safety Parameter 13 (Sprinklers) the value entered in the (People Movement Safety) is recorded in table 5 as 1/2 the corresponding value circled in Table 4.

B. Add the four columns, keeping in mind that any negative numbers deduct.

C. Transfer the resulting total values for S_1, S_2, S_3, S_g to the blocks labeled S_1, S_2, S_3, S_g in Table 7 on page 4 of this sheet.

Table 5. INDIVIDUAL SAFETY EVALUATIONS

SAFETY PARAMETERS	CONTAINMENT SAFETY (S_1)	EXTINGUISHMENT SAFETY (S_2)	PEOPLE MOVEMENT SAFETY (S_3)	GENERAL SAFETY (S_G)
1. CONSTRUCTION				
2. INTERIOR FINISH (Corr. & Exit)				
3. INTERIOR FINISH (Rooms)				
4. CORRIDOR PARTITIONS/WALLS				
5. DOORS TO CORRIDOR				
6. ZONE DIMENSIONS				
7. VERTICAL OPENINGS				
8. HAZARDOUS AREAS				
9. SMOKE CONTROL				
10. EMERGENCY MOVEMENT ROUTES				
11. MANUAL FIRE ALARM				
12. SMOKE DETECTION & ALARM				
13. AUTOMATIC SPRINKLERS			÷ 2 =	
TOTAL VALUE	S_1=	S_2=	S_3=	S_G=

Step 6: Determine Mandatory Safety Requirement Values - Use Table 6.

A. Using the classification of the building (i.e., New or Existing) and the floor where the zone is located, circle the appropriate value in each of the three columns in Table 6.

B. Transfer the three circled values from Table 6 to the blocks marked S_a, S_b, and S_c in Table 7.

Table 6. MANDATORY SAFETY REQUIREMENTS

	CONTAINMENT S_a		EXTINGUISHMENT S_b		PEOPLE MOVEMENT S_c	
ZONE LOCATION	New	Exist.	New	Exist.	New	Exist.
FIRST FLOOR	9.0	4.0	6.0	3.0	6.0	1.0
ABOVE FIRST FLOOR	14.0	8.0	8.0	5.0	9.0	3.0

Step 7: Evaluation Fire Safety Equivalency - Use Table 7.

A. Perform the indicated subtractions in Table 7. Enter the differences in the appropriate answer blocks.

B. For each row check "Yes" if the value in the answer block is zero or greater. Check "No" if the value in the answer block is a negative number.

Table 7. ZONE SAFETY EQUIVALENCY EVALUATION

					YES	NO
CONTAINMENT SAFETY (S_1)	less	MANDATORY CONTAINMENT (S_a)	≥0	S_1 [ ] – S_a [ ] = C [ ]		
EXTINGUISHMENT SAFETY (S_2)	less	MANDATORY EXTINGUISHMENT (S_b)	≥0	S_2 [ ] – S_b [ ] = E [ ]		
PEOPLE MOVEMENT SAFETY (S_3)	less	MANDATORY PEOPLE MOVEMENT (S_c)	≥0	S_3 [ ] – S_c [ ] = P [ ]		
GENERAL SAFETY (S_G)	less	OCCUPANCY RISK (R)	≥0	S_G [ ] – R [ ] = G [ ]		

CONCLUSIONS:

1. [ ] All of the checks in Table 7 are in the "Yes" column. The level of fire safety is at least equivalent to that prescribed by the Life Safety Code.*
2. [ ] One or more of the checks in Table 7 are in the "No" column. The level of fire safety is not shown by this system to be equivalent to that prescribed by the Life Safety Code.*

*The equivalency covered by this worksheet includes the majority of considerations covered by the Life Safety Code. There are a few considerations that are not evaluated by this method. These must be separately considered. These additional considerations are covered in the "Facility Fire Safety Requirements Worksheet." One copy of this separate worksheet is to be completed for each facility.

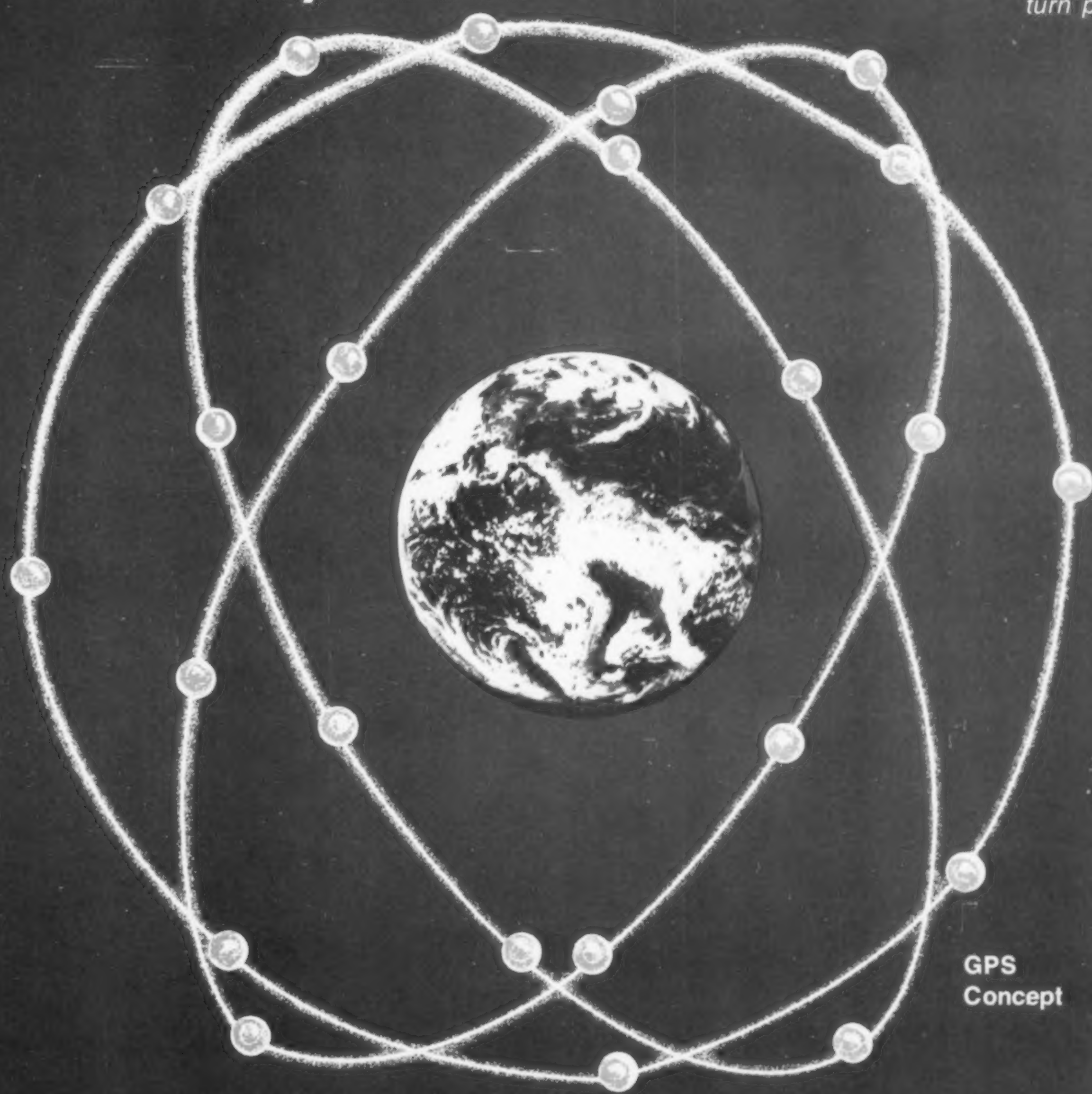
EINSTEIN'S THEORIES AND A NEW SATELLITE SYSTEM

by Collier Smith

One of the points overlooked in much of the excitement surrounding the observance of Einstein's 100th anniversary year is that, for quite a few people, Einstein's theories are a working reality and not just material for lec-

Smith is a writer and a public information specialist with the NBS Boulder Program Information Office.

turn page



GPS Concept

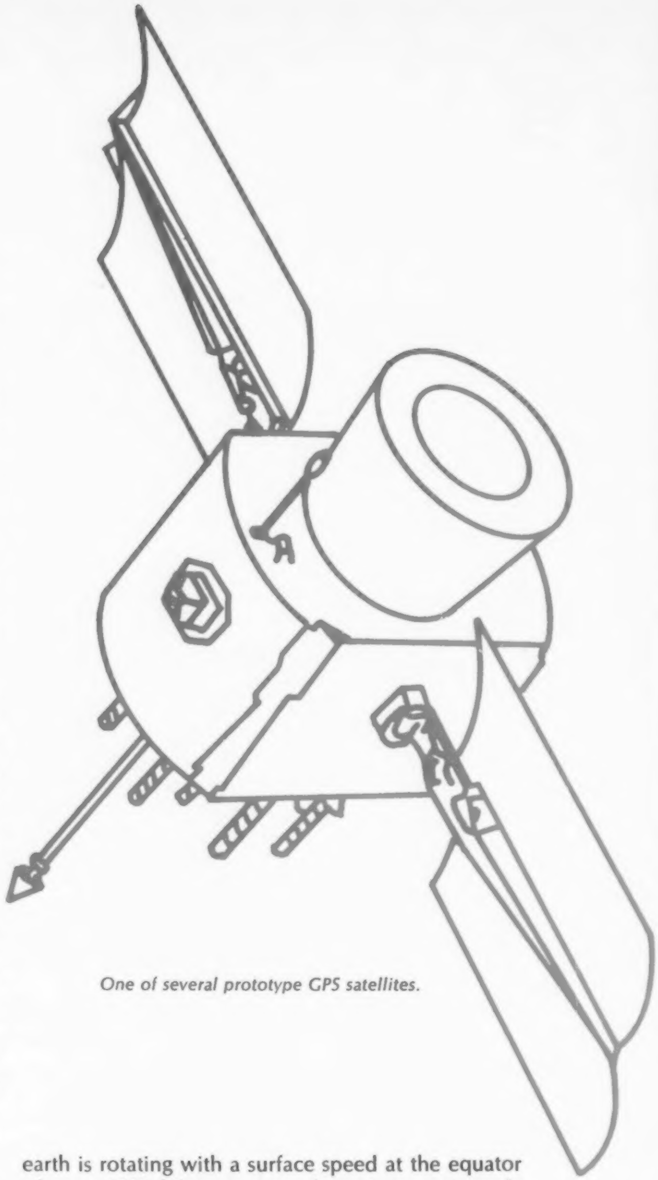
tures by an ivory-tower professor. For them, the equations of Special and General Relativity are an integral part of the daily work of calculating the effects of speed and gravity on systems in operation today.

Thirty-three of these "relativists" met earlier this year at the National Bureau of Standards' Boulder, Colorado, laboratories for a seminar on relativity and its effects on the operation of a satellite network called the Global Positioning System (GPS). The GPS, when completed in the mid-1980's, will be the backbone of the Department of Defense Navigation System for military services, and potentially could be used by civilian ships and aircraft and others who want to know their position accurately in three dimensions—latitude, longitude, and altitude (four dimensions if time is included).

The GPS will eventually consist of 24 satellites carrying atomic clocks and orbiting the earth in three planes. Four or five of the satellites will be above the horizon at all times from every point on earth. Each one will transmit signals containing information on its position and the time of day, and the difference between its time and GPS system time, which will be maintained in nominal synchronization with Coordinated Universal Time (UTC). Four automated ground monitor stations around the world, plus a master control station, will make accurate position and time determinations to update each satellite's data every few hours.

By receiving data from four satellites at the same time, a user's receiver/computer will obtain enough information to solve four simultaneous equations that collectively will give the user's position to within 10 meters and the time (relative to UTC) to within 100 billionths of a second.

Einstein's theory of relativity enters this picture because of the high altitude of the satellites (20 200 kilometers), their high speed, the rotation of the earth, and the speed of the user. To an observer with a clock at a low altitude, another clock at a higher altitude will appear to run faster. On the other hand, if two clocks are moving at high speed with respect to each other, the observer with one clock will see the other clock running slower. However, these effects do not cancel each other out except for one specific orbital height (much lower than the GPS orbit). In fact, the combined relativistic effects on the GPS could amount to as much as a 12-kilometer error in navigation in one day if Einstein's equations were not used. Even clocks on board airplanes show these altitude and speed effects, and the fact that the earth is rotating with a surface speed at the equator of over 1600 kilometers per hour is an extremely important consideration.



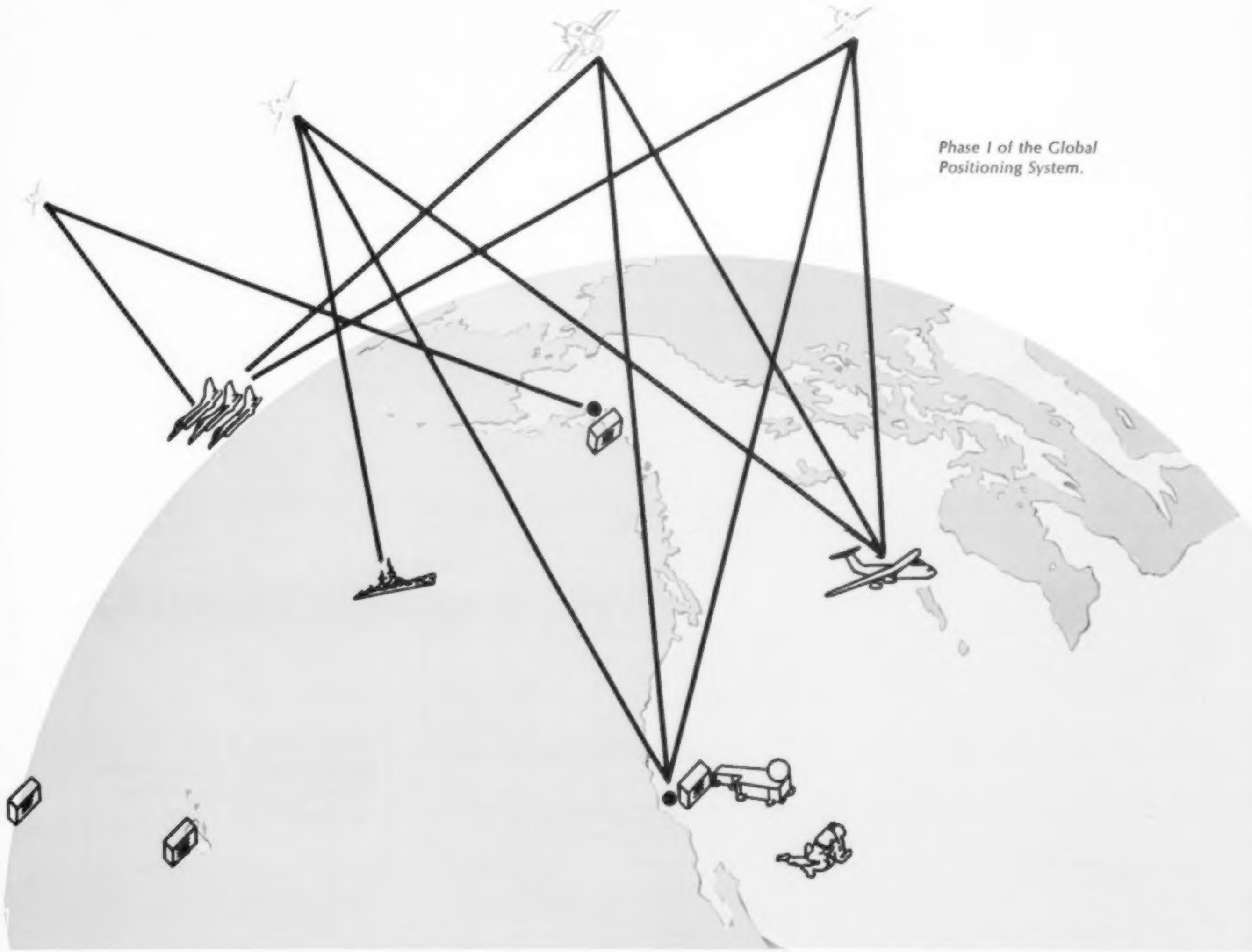
One of several prototype GPS satellites.

Some of the relativistic effects can be accommodated simply by setting the satellite clocks to run slightly slower than the master clocks on the ground. The others will be taken care of by computer calculations done by the user's equipment. Some of this equipment will be so light and compact that it will fit into a backpack, enabling ground troops to locate themselves precisely on a battlefield even in total darkness.

Interestingly, some of the relativists at the NBS meeting argued that the gravity of the sun would have an appreciable effect on the system, while others said that these effects would be negligible. General agreement was reached that the effects of the sun's gravitational field would cause navigational

errors much smaller than a centimeter. Several experiments were cited by participants in direct support of this conclusion.

The first four GPS satellites are already in orbit with atomic clocks on board; these first models will lead to improved designs for the remaining GPS components. During the development of the system, different research and development groups were treating the various relativistic corrections in different ways, and NBS suggested holding a meeting to resolve the inconsistencies. The Space and Missile Systems Organization (SAMSO) of the Department of Defense then asked NBS to host a seminar for GPS contractors, SAMSO managers, and a panel of relativity experts from the Universities of Colorado and Maryland, the U.S. Naval Observatory, the Harvard Smithsonian Center for Astrophysics, the Defense Mapping Agency, and NBS. After discussing the total effects of relativity on GPS, the panel concluded that relativistic corrections are currently being applied so that all significant errors are being accommodated. Thus, future GPS development will proceed without controversy over these basic concepts. □



Phase I of the Global Positioning System.

NBS SEEKS PROPOSALS FOR COMPUTER STANDARDS DEVELOPMENT AND FOR SYSTEMS SECURITY PROGRAM

by Stan Lichtenstein

The National Bureau of Standards is looking for organizations interested in working on an expanded program to develop Federal computer standards for higher level programming languages and software quality. In a separate effort, the Bureau is seeking organizations with research and development capabilities to assist NBS in its computer systems security program.

Standards

Organizations with research and development capabilities in the areas of programming languages and software are being invited to submit proposals for specific projects to assess the benefits and costs and develop the foundations for future standards.

These projects are designed to assist the Bureau in assessing higher level programming and software quality, and in developing guidelines, validation methods, applicability criteria, and compliance monitoring methods for a comprehensive family of Federal standards for languages and software development.

Specific work areas will include:
—transferability of programs
—language analyzers
—language processor testing
—design and testing methods
—programming techniques
—current languages and extensions
—documentation
—general software engineering

Proposals for cost-benefit studies in all work areas will be solicited.

Systems Security

NBS will also soon solicit proposals for specific projects to assess current computer security technology and to develop the foundation for future Federal computer standards.

The computer security projects will be directed toward:

—assessing current techniques and procedures for managing risks of and providing security for computer systems;

—developing guidelines, validation methods, applicability criteria, and compliance monitoring methods for a comprehensive family of computer systems security standards.

Specific work areas will include risk analysis, security certification, computer data cryptography standards, user authorization schemes, and contingency planning. Proposals for cost-benefit studies in all work areas will be solicited.

Proposals and Contracts

The Department of Commerce's contracting procedures are now in progress. Prospective contractors are invited to become familiar with the objectives of the Federal computer standards program. For information about how to obtain background literature, including the Federal Information Processing Standards (FIPS) and NBS Special Publication 500- series, contact R. L. Raybold, Program Contract Manager, Technology B250, National Bureau of Standards, Washington, D.C. 20234.

Organizations interested in these projects are invited to provide brief descriptions of their capabilities, key technical personnel, and recent related activities. This information should be sent to R. L. Raybold.

NBS encourages public interest in these projects and the submission of innovative ideas and suggestions. Unsolicited proposals will be handled in accordance with regular NBS and Department of Commerce procedures.

Emphasis will be placed on maximum possible use of small business organizations and organizations owned or controlled by socially or economically disadvantaged individuals as contractors or subcontractors.

Lichtenstein is a public information specialist in the NBS Public Information Division.

STAFF REPORTS

NEW COMPUTER NETWORK FOR NBS

The National Bureau of Standards is developing a high-speed local data network to serve its internal data communication needs. In the following report, NBS researchers describe the technical features of the network that they designed to link the computer terminals, data acquisition equipment, laboratory minicomputers and full-size computers at the NBS Gaithersburg laboratories.

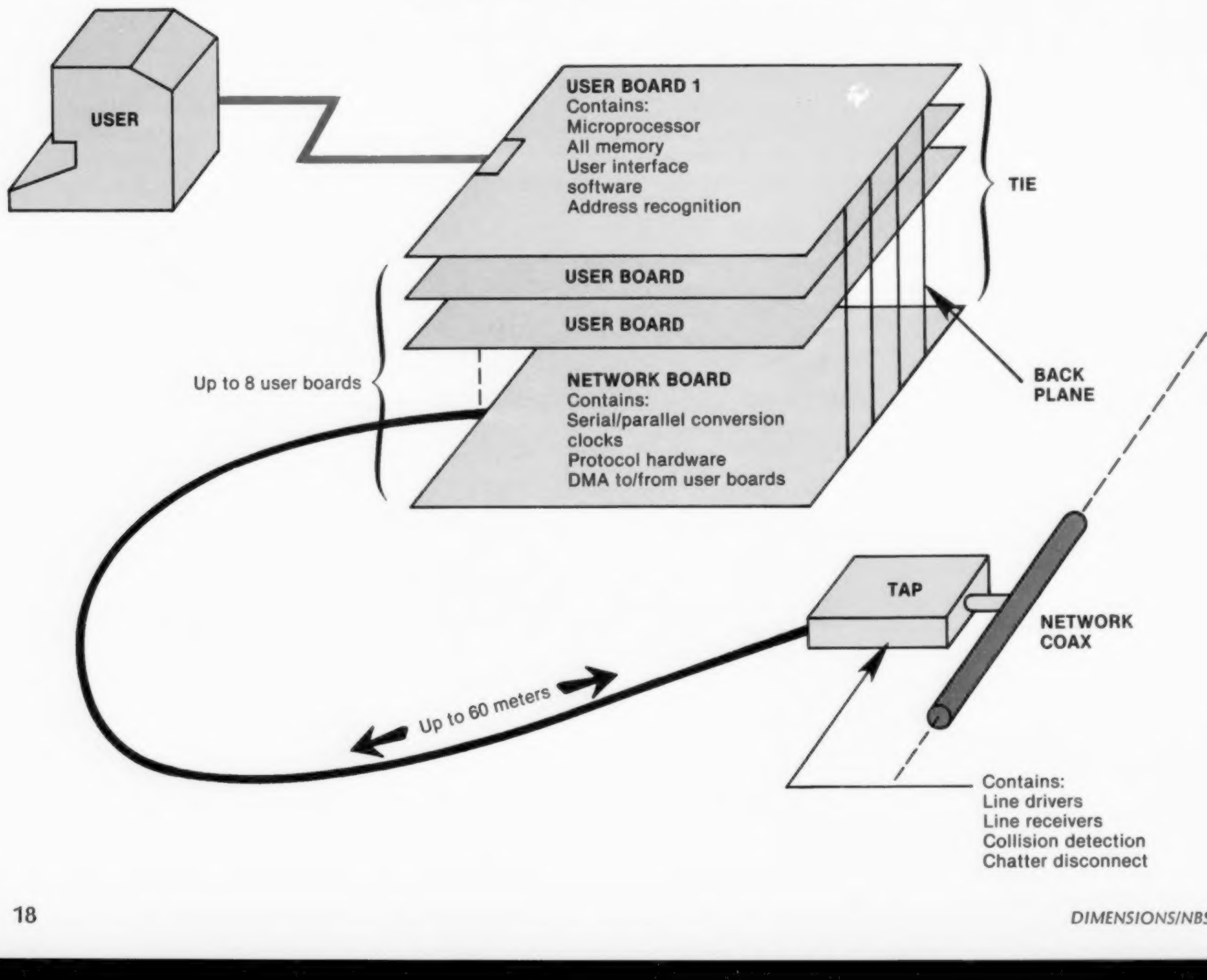
Robert J. Carpenter, Joseph Sokol, Jr., and J. Eryx Malcolm, Institute for Computer Sciences and Technology, A219 Technology Building, 301/921-3427.

Local data networks are meeting organizational needs for data communications over a limited geographic area such as a campus, factory, or office complex in much the same way that national and international computer networks serve geographically dispersed users. Users experimenting with local networks have adopted a variety of techniques and approaches to meet their system requirements and equipment capabilities.

Three years ago, a study of the data communications needs at NBS identified about 700 user devices consisting of two major computers, about 60 smaller computers, and about 300-500 terminals. Analysis of user needs and equipment characteristics showed that a network linking these dissimilar devices, each operating at different data communication rates, would require the following capabilities:

- full connectibility for terminals, microcomputers, minicomputers, major

Figure 1—*Summary of major characteristics of NBS network.*



host computers, and laboratory instruments;
- speed conversion over the range of at least 110 to 9600 bauds with the required flow control;
- address at least 2000 user nodes, a few hundred simultaneously;
- cover a site 1.5 km long with about 20 buildings;
- provide ease of user access;
- provide data encryption if needed;
- be tolerant of the failure of a large number of user interface nodes.

Overall System Characteristics

Plans for a local data network meeting these requirements for NBS users were developed and installation of the network, approved by the NBS Executive Board, has begun. The approach selected was an adaptive time division multiple access cable system with fully distributed control. Existing coaxial cables installed as part of NBS's internal standard frequency distribution system form part of the network. Major characteristics of the network are summarized in Figure 1.

A microprocessor-based node, called Terminal Interface Equipment or TIE, was developed to connect user devices to the coaxial cable. These microprocessor-based units interconnect user devices with different signalling speed requirements and control the data flow on the network. Any user can establish a connection with any other network user as in a telephone system. Other features provided by the TIE's are error detection and automatic retransmission capabilities. Additionally, TIE's can perform certain line editing functions and data encryption/decryption with the addition of a data encryption integrated circuit.

Technical Features of System

Data is transmitted by packets, with end-to-end flow control, allowing user stations operating with different bit rates to communicate with each other. A typical packet is shown in Figure 2.

The TIE is designed to provide for efficient control of data through the network. Before starting transmission of data, the TIE checks to be sure that the cable is free. If, however, two TIE's start to use the cable at the same time, each will detect packet collisions at the moment that they occur.

When such collisions are detected, each party to the collision will immediately truncate the packet being transmitted and impose a random waiting period before attempting to regain control of the cable. Since collisions usually occur near the start of a packet, truncation avoids tying up the network with complete transmissions of already damaged packets. This type of "contention" for the cable with detection and delay before retransmitting results in highly efficient use of the cable channel's data transmission capacity.

User-to-User protocol is built upon the User-to-TIE; TIE-to-TIE; and TIE-to-User protocols. The implementation of the User-to-TIE and TIE-to-User protocol takes into account differences in the requirements of different user terminals, processors, and mainframes. Differences are recognized and the software is "personalized" to the local user devices.

The TIE is illustrated in Figure 3. Its major sections are the network board (NB) and the user board(s) (UB), managed by a microprocessor and its associated erasable-programmable read-only memory (EPROM). The TIE output from the NB is coupled to the coaxial distribution cable by a TAP, which contains a line receiver, line driver, the collision detector, and a circuit to disconnect a TIE when necessary.

The NB/TAP can support eight UB's. Functions such as communication control, message buffering, assembly of data packets and error control reside on each UB. A UB is required for each connected user device. This allows effective clustering with a saving on hardware, yet does not penalize the single-user TIE. Multi-UB TIE's also result in an improvement in the efficiency of use of the shared network cable, since the UB's sharing the single NB are polled and do not contend with each other.

Implementation Plans and Network Use

A production contract for the first complement of TIE's has resulted in first de-

Sync	Sync	Destination Address	Source Address	Control Field	Optional Data Field	CRC

Figure 2—*Typical packet.*

turn page

liveries in spring 1979. Plans call for the interconnection of 50-60 terminals and computer data communication interfaces by fall. Additional network connections will be made later in accordance with a planned implementation schedule.

Figure 3—*NBS network hardware.*

NBS Network

Coaxial cable bit rate	1 megabit/second
Signaling method	On/Off, Manchester
Maximum packet size	136 bytes
Maximum packet duration	1.088 milliseconds
Data bytes per packet	0 to 128
Number of addresses in packet	Two (destination, source)
Size of address fields	16 bit (65K addresses) One address is reserved for broadcast messages which are accepted by all TIES
Error control	16-bit error control CRC
Basic contention protocol	Ethernet
Connection to user equipment	Serial asynchronous, RS-232C or RS-449; parallel possible
Bit rate to user equipment	Common speeds up to 9600 bauds
Flow control	End-to-end, in-band or out-of-band to suit user equipment

SCIENTIFIC TOOLS FOR THE ART WORLD: AUTORADIOGRAPHY AND GAMMA-RAY SPECTROSCOPY

Researchers are testing whether two methods of radioactive analysis can help determine the age of a painting and the identity of the artist.

Donald Garrett, Reactor Radiation Division, A108 Reactor Building, 301/921-3634.

The Smithsonian Institution and the National Gallery of Art are funding a feasibility study to employ nuclear technology for authenticating reportedly valuable paintings and for dating and possibly attributing to a specific artist works of unknown origin. This project is being conducted by a team of scientists from the National Bureau of Standards, the Smithsonian Institution, the National Gallery of Art, the Armed Forces Radiobiological Institute, and a private art conservator. The methods under investigation are neutron-induced autoradiography and high-resolution gamma-ray spectroscopy. The irradiation required for both these techniques yields a painting radioactive for a brief period. The research group will attempt to determine whether the radiation permanently alters the work in any way.

Both methods of analysis are conducted simultaneously: A painting is placed in a thermal neutron field from a nuclear reactor, rendering the elements contained in the painting pigments temporarily radioactive. The degree of radioactivity induced is dependent upon several factors characteristic of the density of the pigments, the amount of pigment present and the probability of a neutron interaction with the elements contained in the pigments.

Autoradiography is achieved by placing radiographic films in direct contact with the painting at periodic intervals, causing film exposure by beta rays as the radioactive pigments decay to their ground states.

Figure 1—*Nineteenth century landscape, oil painting by an unknown artist.*

By interpreting these autoradiographs, it may be possible to identify within them characteristics which relate to a particular artist, such as methods of applying pigments, brush strokes, and style of painting.

Gamma-ray spectroscopy is being used to identify the elemental content of the painting. Such information is useful as dating evidence because elemental content in pigments has continually changed through the ages.

The accompanying illustrations show the results obtained from a test involving a 19th century painting by an unknown artist.

Figure 2—*Neutron-induced autoradiograph obtained 4 hours after irradiation.*

Figure 3—*Neutron-induced autoradiograph obtained 4 weeks after irradiation.*

turn page

MATRIX ISOLATION RAMAN SPECTROSCOPY

Researchers at the National Bureau of Standards have developed a new primary laboratory measurement method for testing field standards and measurement techniques used to detect trace amounts of toxic organic substances in water.

David S. King and John C. Stephenson, Molecular Spectroscopy Division, B268 Physics Building, 301/921-2766.

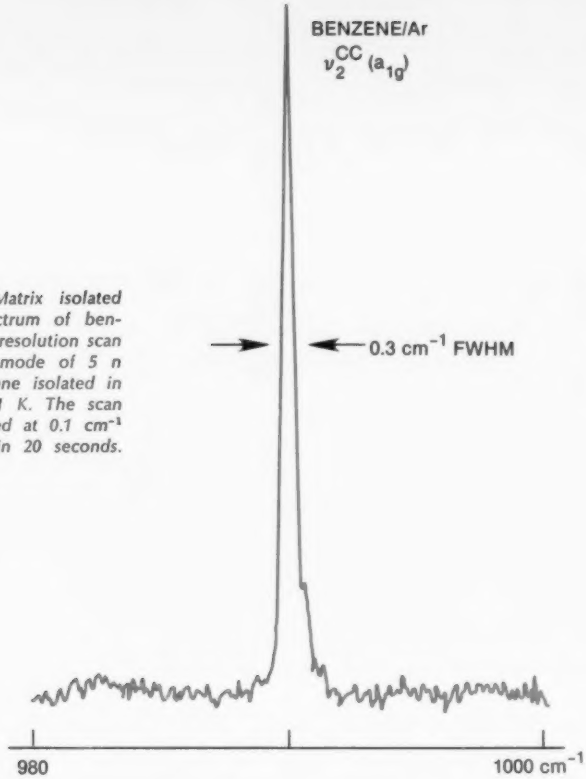


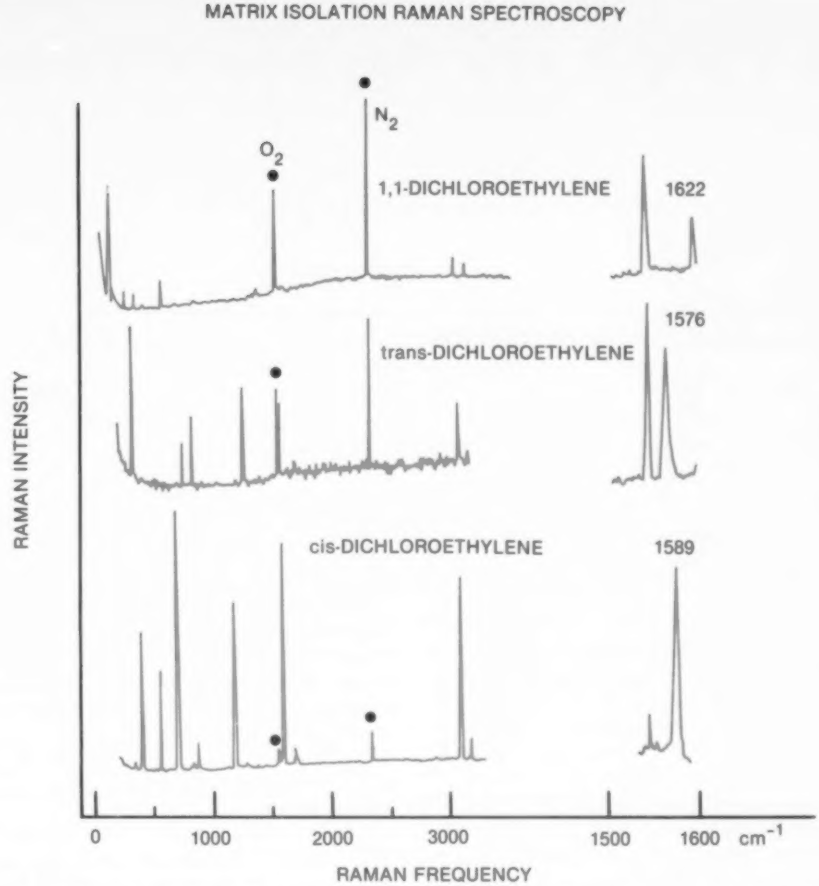
Figure 1—*Matrix isolated Raman spectrum of benzene. High resolution scan of the ν_2 mode of 5 n gram benzene isolated in argon at 11 K. The scan was acquired at 0.1 cm^{-1} resolution in 20 seconds.*

Until this decade, the assessment of pollutant levels in water was based on measurements of such properties as total organic carbon or biochemical oxygen demand. Although it was known that these tests did not take into account the toxic properties of specific chemicals, it was not until the discovery of specific toxic and carcinogenic substances in drinking water supplies in the early 1970's that programs to routinely identify and quantify very low concentrations of specific organic compounds were initiated. Now, phrases such as consent decree pollutants and priority pollutants which reflect the legislative and regulatory mandates of the last few years are commonly heard in discussions of environmental assessment. In response to the need to identify and quantify low concentrations of organic compounds in environmental samples, a new arsenal of sophisticated analytical instruments is appearing in environmental laboratories. All use liquid or gas chromatography to separate the many compounds found in environmental samples. The individual components emerge sequentially from the chromatograph, swept along by the carrier gas or liquid. The technical challenge of the past ten years has been to develop methods to identify and measure the individual compounds in the few seconds during which they emerge from the chromatograph.

Several months ago, we initiated a program to develop a primary laboratory measurement method suitable for analysis of Standard Reference Materials (SRM's) or for referee-type measurements of trace toxic organics in water. This new method, involving laser Raman scattering from pollutants isolated in cryogenic matrices, should provide an alternative technique for the analysis of pollutants of the type on the EPA lists of regulated chemicals with a molecular specificity and sensitivity comparable to, or better than, existing techniques (e.g., gas chromatography and mass spectrometry).

Any realistic approach to the identification and quantification of individual trace organic compounds in a complex sample must begin with the application of modern separation procedures, such as liquid or gas phase chromatography. However, even very efficient separation procedures may be unable to do more, in a realistic time frame, than to produce a series of fractions which themselves are rather complex mixtures. Therefore, any successful analytical procedure for the qualitative and quantitative analysis of complex mixtures of organics must incorporate a secondary and molecule-specific measurement method. Our approach involves three steps: 1) sample acquisition and initial separation, 2) matrix isolation, and 3) spectroscopic analysis. The total volatile pollutant content of the aqueous sample will be acquired by dynamic headspace sampling followed by concentration on a precolumn, and then separation on a gas chromatography (GC) column using argon as the carrier gas. The GC will separate the initial mixture into several fractions containing either a single or small number of physically or chemically similar molecular species. As the pollutants elute out the GC, a responsive valving system will be used to take cuts, or small sample amounts, of the effluent stream. These cuts will then be sprayed onto a cold finger, cryogenically maintained at 12 K. Both the organic pollutant and the argon carrier gas are frozen in a spot approximately 1 mm in diameter. The cold finger is rotated, in a step-like fashion, between sample cuts to maintain the initial sample separation achieved in the GC. Each sample containing only the compounds, if any, that emerged from the chromatograph during a specific one to three second period and now frozen, dilute in an argon matrix, is sequentially analyzed by matrix isolated laser Raman spectroscopy as it is stepped into view of a high resolution spectrometer. If chemical compounds are present in the region irradiated by the laser, they will re-emit light at wavelengths different from the wavelength of laser. This re-emitted light, called Raman scattered light after the Indian scientist who first observed the effect 75 years ago, is characteristic of

Figure 2—*Matrix isolated Raman spectra of three dichloroethylene isomers. The spectra were acquired at 5 cm^{-1} resolution in 10 minutes. The dotted peaks are O_2 and N_2 "spiked" into the initial gas mixtures to aid in quantification. Also shown, to the right, is a closer look, at 1 cm^{-1} resolution, of the 1500-1600 cm^{-1} region.*



the compound(s). The intensity of the Raman scattered light is proportional to the amount of the compound present. As in the other detectors that have been developed for chromatographs, a small computer is needed to analyze the vast amount of data being generated and to present it in a form useable by the environmental analyst.

We use matrix isolated laser Raman spectroscopy as our diagnostic means for several reasons: 1) Raman spectroscopy is a vibrational spectroscopy and as such provides a characteristic and reproducible "fingerprint" that carries structural information to allow for the unambiguous identification of unknown contaminants; 2) All molecules have characteristic Raman spectra in an experimentally convenient spectral range; 3) The matrix substrate (in this case argon) is free of organic contaminants and has no spectral interferences; it is transparent and allows the vibrational frequencies of the trapped pollutant to be readily compared to the gas phase values of known, pure compounds; 4) At the low temperatures used, all rotational motion is frozen out, and the spectral linewidths are very sharp, so sharp that the overlapping of bands observed in solution and in the gas phase is not a problem.

Although the engineering aspects of interfacing the technologies of sample acquisition, gas chromatography, and matrix preparation have not been fully implemented, we have obtained matrix isolated Raman spectra of laboratory samples of many of the toxic organics on the EPA's regulated list: benzene and substituted benzenes, halo-methanes, ethylenes, and ethanes. Significantly, we observed vibrational bandwidths of about 1 cm^{-1} (see Figure 1). By contrast, room temperature gas or liquid phase bandwidths are about 50 cm^{-1}; with such large bandwidths the spectral lines of many toxic and non-toxic compounds overlap, making analysis difficult or impossible. On the other hand, due to the narrowness of the spectral features in the low temperature matrix, spectra of these molecules are readily resolved; we have no difficulty, for instance, analyzing mixtures of different molecular isomers (molecules with the same chemical formula but differing arrangements of the constituent atoms) such as cis, trans, and 1,1-dichloroethylene (see Figure 2). With our present and far from optimum, optics and low-power laser we can readily detect nanogram quantities of a wide variety of toxic organics.

Matrix isolated Raman spectroscopy may be favorably compared to the other techniques utilized in the analysis of low-level mixtures of complex organic species. Although similar in principle to infrared absorption spectroscopy, Raman spectroscopy is inherently more sensitive (basically, in Raman spectroscopy one looks for small signals in the absence of any background while in infrared absorption one looks for a small change in an otherwise very large continuum background). The Raman process is not prone to the interference problems that energy transfer introduces to fluorescence type measurements. Also, many regulated pollutants either do not fluoresce or they have electronic absorption spectra which are very broad or are in the experimentally difficult vacuum ultraviolet region. Although mass spectrometry has an equivalent sensitivity, it does not have the specificity of the Raman diagnostic (mass spectrometry cannot readily distinguish between similar species, such as isomers, even when one of these is regulated by the EPA while others are not).

The work to date has clearly demonstrated the feasibility of our technique for preparing and spectroscopically analyzing small quantities of complex organic molecules. We are now planning to use high-intensity pulsed laser Raman scattering, with gated electronics, to improve sensitivity and an optical multichannel analyzer with computer interfacing to reduce sampling time and to provide for rapid comparison of an "unknown" spectrum to reference spectra. The feasibility of interfacing our sensitive detection apparatus to a liquid chromatograph for the analysis of non-volatile environmental and biological samples is currently under study. Although in its initial stages of development, this method, which is being developed with partial support by the U.S. Environmental Protection Agency, promises to be a major advance in the analysis of organic compounds.

CONFERENCES

For general information on NBS conferences, contact JoAnn Lorden, NBS Public Information Division, Washington, D.C. 20234, 301/921-2721.

TESTING LABORATORY PERFORMANCE SUBJECT OF NBS CONFERENCE

Programs and systems used by private and governmental agencies to accredit, certify, or provide acceptance status of laboratories which test specific materials and products will be discussed at a conference to be held September 25-26, 1979 at the National Bureau of Standards in Gaithersburg, Maryland.

The National Conference on Testing Laboratory Performance Evaluation and Accreditation is sponsored by the Bureau's Office of Engineering Standards.

Testing laboratories are being subjected to ever-increasing numbers of examinations, audits, and inspections to insure their testing capability by a variety of bodies, both public and private. The two-day session is designed to provide a forum for the dissemination of information and the exchange of ideas about techniques available for evaluating the performance of testing laboratories.

The conference will consist of a series of invited presentations and contributed papers. Papers have been solicited for sessions in the following areas:

Laboratory performance evaluation

Interlaboratory round robins
Split sample techniques
Measurement assurance programs
Collaborative reference programs
Quality assurance in the testing laboratory.

Laboratory evaluation techniques

Information gathering—written descriptions, questionnaires
On-site examination—peer review, audits, inspection
Proficiency testing

Laboratory accreditation systems

Voluntary governmental accreditation programs
Association accreditation programs
Private accreditation programs
Regulatory agency accreditation programs
Foreign and international accreditation programs
Laboratories' views of accreditation programs

A registration fee will be charged to help defray the cost of conducting the conference. For further information, contact Dr. Berman, Office of Testing Laboratory Evaluation Technology, B06 Technology Building, 301/921-2427.

NCSL SYMPOSIUM AND WORKSHOP

"Challenges for the Professional Metrology Manager of the Eighties," will be the theme of the 18th annual workshop and symposium of the National Conference of Standards Laboratories (NCSL) on October 15-17, 1979, at the Hilton Harvest House Hotel in Boulder, Colorado.

Dr. Lewis M. Branscomb, Vice President and Chief Scientist of IBM, will be the keynote speaker at the opening session, Monday, October 15. Other invited speakers and panelists will be from private, government, and educational institutions ranging in size from one-man operations to the Nation's foremost measurement laboratory, the National Bureau of Standards.

Participants at the three-day meeting will address the changing needs of modern metrology in areas such as laboratory personnel (hiring, training, and motivation); laboratory management (instrument inventory, finance, and records); radiation standards; measurement assurance programs (MAP); traceability; introduction to optical-fiber standards; and preparing management for metrology's role in the future. Extensive discussion periods will follow each presentation to facilitate the informal exchange of ideas among participants.

A final session on Wednesday afternoon will be a "Meet the Scientists" open house of the NBS laboratories in Boulder.

The National Conference of Standards Laboratories is a non-profit professional organization of some 400 standards laboratories, calibration laboratories, and organizations that maintain such laboratories or have an interest relating to metrology. NCSL was chartered September 15, 1961, to help individual laboratories solve their common problems. It is sponsored by NBS.

For further information on the technical program of the 1979 NCSL Symposium and workshop, contact Hartwell Keith, Co-chairman, Ford Aerospace and Communications Corporation, Aeronutronic Division, Ford Road, EVT 26, Newport Beach, California 92663, telephone 714/759-5520.

To receive conference mailings or obtain information on registration, housing and other local arrangements, contact Kenneth Armstrong, Co-chairman NCSL Sercetariat, 4001 Radio Building, National Bureau of Standards, Boulder, Colorado 80303, telephone 303/499-1000, ext. 3787.

CONFERENCE ON MEASUREMENT METHODS, STANDARDS FOR RECYCLED OIL

Measurement methods and standards for recycled oil used as automobile crankcase oil will be the major topic at a conference to be held at the National Bureau of Standards in Gaithersburg, Maryland, October 23-26, 1979.

The Conference on Measurements and Standards for Recycled Oil/Systems Performance and Durability is cosponsored by NBS, the Mechanical Failures Prevention Group, and the ASTM Technical Division P on Recycled Petroleum Products and Lubricants. The conference will consist of invited lectures by experts in various fields of petroleum testing and evaluation, systems performance, and materials durability.

The conference program tentatively includes sessions on:

—Recent developments in recycled oil

—Re-refined engine oil evaluation: current efforts

—Lubricating base oil characterization: quality and consistency

—Oil analysis for engine condition monitoring

—Bench test for oil evaluation: oxidation, deposits, wear, friction, and corrosion

—Systems performance and durability through wear and fatigue testing

Currently, about 1.2 billion gallons (4.5 billion liters) of used oil are generated annually in the United States. Of the used oil collected each year, oil companies estimate that approximately 7 percent is re-refined into motor oils, 17 percent is reclaimed into industrial oils, about 50 percent is burned for fuel or used in road oiling or dust control, and the remaining 25 percent (about 300 million gallons) is unaccounted for and presumed dumped.

Recycled lubricating oil products have not met with widespread consumer acceptance in either the government or the private sector because of the lack of reliable test procedures and standards on which realistic performance criteria can be based. In the Energy Policy and Conservation Act and the Resource Conservation and Recovery Act, NBS is directed to develop such test procedures and standards. These procedures will provide the basis for Federal Trade Commission trade regulation rules for industry-wide performance standards and labeling requirements for recycled oil.

To register for the conference, write or call Kathy Stang, B348 Materials Building, Washington, D.C. 20234, 301/921-3295. For additional technical information, contact Donald Becker, NBS Recycled Oil Program, or Harry Burnett, Metal Science and Standards Division, National Bureau of Standards, Washington, D.C. 20234.

CONFERENCE CALENDAR

August 13-15

SIMULATION, MANAGEMENT, AND MODELING OF COMPUTER SYSTEMS, NBS, Gaithersburg, MD; sponsored by NBS; contact: Paul Roth, B250 Technology Building, 301/921-3545.

September 5-7

SYMPOSIUM ON EDDY CURRENT NONDESTRUCTIVE TESTING, NBS, Gaithersburg, MD; sponsored by NBS, ASTM, and ASNT; contact: George Birnbaum, A363 Materials Building, 301/921-3331.

***September 11**

4TH ANNUAL NBS-NCSBCS JOINT CONFERENCE ON RESEARCH AND INNOVATION IN THE BUILDING REGULATORY PROCESS; Chase Park Plaza, St. Louis, Missouri; sponsored by NBS; contact: Sandra Berry, B226 Technology Building, 301/921-2689.

September 18-21

IMPACT OF IMPROVED CLOCKS AND OSCILLATORS ON COMMUNICATION AND NAVIGATION SYSTEMS WORKSHOP; Gaithersburg, MD; sponsored by the Air Force Office of Scientific Research with the Cooperation of NBS; contact: S. Stein, NBS, Boulder, 303/499-1000, ext. 3277.

September 25-26

NATIONAL CONFERENCE ON LABORATORY EVALUATION; NBS, Gaithersburg, MD; sponsored by NBS; contact: G. Berman, 301/921-2427.

October 9-11

FOURTH ANNUAL CONFERENCE ON MATERIALS FOR COAL CONVERSION AND UTILIZATION, NBS, Gaithersburg, MD; sponsored by NBS and DOE; contact: Samuel Schneider, B308 Materials Building, 301/921-2893.

October 23-26

JOINT CONFERENCE ON MEASUREMENT AND STANDARDS FOR RECYCLED OIL/SYSTEMS PERFORMANCE AND DURABILITY, NBS, Gaithersburg, MD; sponsored by NBS, MFPG, ASTM Technical Division P on Recycled Petroleum Products and Lubricants; contact: Donald Becker, B50 Physics Building, 301/921-2621, or Harry Burnett, B264 Materials Building, 301/921-2812.

December 3-5

1979 WINTER SIMULATION CONFERENCE, San Diego, California; sponsored by NBS, AIIE, ACM, IEEE, ORSA, TIMS, and SCS; contact: Paul Roth, B250 Technology Building, 301/921-3545.

*New Listing

PUBLICATIONS

CALIBRATING TWO 6-PORT REFLECTOMETERS

Calibrating Two 6-Port Reflectometers With Only One Impedance Standard, *Hoer, C. A., Nat. Bur. Stand. (U. S.), Tech. Note 1004, 46 pages (June 1978) Stock No. 003-003-01956-9, $1.60.**

A 6-port reflectometer is a versatile device used to measure the impedance or reflection coefficient of 1-port electronic components connected to it, as well as voltage, current, or power. Two reflectometers can be used to measure all of the scattering parameters of a 2-port device inserted between them.

The text describes a technique for calibrating a pair of 6-port reflectometers using one simple, inexpensive standard. The operations in the calibration consist of connecting the two 6-ports together, connecting each 6-port to a calibration circuit consisting of two terminations of unknown impedance and a leveling loop, and then connecting the standard.

The standard can be one termination whose complex impedance is known, or a precision length of transmission line whose cross-sectional dimensions are known. The length and loss of the line are immaterial. The solution for the constants which characterize each 6-port is closed, requiring no iteration.

The text gives a complete description of the calibration technique and related computations, and an appendix adds a simple outline of a typical computer program for taking, storing, and calculating the calibration data.

Publications cited from this point on may be purchased at the listed price from the U.S. Government Printing Office, Washington, D.C. 20402 (foreign: add 25%). Microfiche copies are available from the National Technical Information Service, Springfield, VA 22161. For more complete periodic listings of all scientific papers and articles produced by NBS staff, write: Editor, Publications Newsletter, Administration Building, National Bureau of Standards, Washington, D.C. 20234.

DETECTOR SPECTRAL RESPONSE

Detector Spectral Response from 350 to 1200 nm Using a Monochromator-Based Spectral Comparator, *Corrons, A., and Zalewski, E. F., Nat. Bur. Stand. (U.S.), Tech. Note 988, 21 pages (Dec. 1978) Stock No. 003-003-02000-1, $1.20.*

For many radiometric and photometric measurements it is necessary to know the spectral response of the specific detector selected for the experiment. A detector's spectral response may be determined by measuring its output either relative to a detector of known spectral response or when irradiated by a set of lamp and filter combinations of known spectral irradiance.

In this study, the researchers examined both the method of monochromator-based spectral comparison measurement and the method of detector spectral response measurement using a spectral irradiance lamp and several narrow-band interference filters. The study was undertaken to evaluate these techniques, which have been used for many years to measure detector response.

The method of relative spectral detector response measurement based on filters of known transmittance and a spectral irradiance standard lamp was used to measure the responsivity of a thermopile. The thermopile was then used in conjunction with a monochromator-based spectral comparator to measure the relative spectral response from 350 to 1200 nm of several other detectors. Several auxiliary experiments to evaluate the accuracy of these techniques are described.

FIRE TEST ON FURNISHINGS

The Calibration of a Burn Room for Fire Tests on Furnishings, *Tu, King-Mon, Babrauskas, V., Nat. Bur. Stand. (U.S.), Tech. Note 981, 59 pages (Dec. 1978) Stock No. 003-003-01999-2, $2.30.*

This report documents a series of ten tests conducted in a full-size room designed for furnishings flammability tests.

Fire incidence data show that upholstered furniture and other furnishings are the major contributors to all fire deaths, but full-scale experiments are necessary to identify the sequential process of fire development. For this purpose, a burn room was constructed in which a wide variety of tests could be conducted and instrumentation was installed to measure the appropriate physical and thermal changes. A gas burner was used as a heat source to characterize and calibrate the burn room for the full-scale experiments. Temperatures, gas velocities, and heat flux were recorded during the tests.

The gas burner was used to release known heat rates and to permit steady state measurements of energy and mass flow. The gas burner fires simulated pre-flashover conditions, with peak temperatures outside the burner plume of around 300 °C. Measurements that were obtained during tests were compared with available theoretical room fire descriptions and published heat transfer values.

The results showed the importance of a precise determination of the inflow and exhaust velocities at the doorway. It was demonstrated that a large number of doorway velocity probes is required to accurately obtain a room heat and mass balance. A calculational procedure was developed for analyzing the results which should be useful for future analysis of furnishings experiments.

Analytical Chemistry

Davis, R. S., and Bower, V. E. A Novel Method for Analyzing Silver Sediment With High Precision, J. Res. Nat. Bur. Stand. (U.S.), *84*, No. 2, 157-160 (Mar.-Apr. 1979).

Building Technology

Cooke, P. W., Ed., Selected Papers Dealing With Regulatory Concerns of Building Rehabilitation, Nat. Bur. Stand. (U.S.), Spec. Publ. 536, 93 pages (Feb. 1979) Stock No. 003-003-02032-0, $2.75.

Gallagher, N., Ed., Building Research at the National Bureau of Standards 1968-1974, Nat. Bur. Stand. (U.S.), Bld. Sci. Ser. 75, 126 pages (Mar. 1979) Stock No. 003-003-02029-0, $3.

Olmert, M., and Raufaste, N., Eds., Building Technology Project Summaries 1977-1978, Nat. Bur. Stand. (U.S.), Spec. Publ. 446-2, 108 pages (Jan. 1978) Stock No. 003-003-02021-4, $3.25

Yancey, C. W. C., and Cattaneo, L. E., The Development of an Improved Compression Test Method for Wall Panels, Nat. Bur. Stand. (U.S.), Bldg. Sci. Ser. 95, 108 pages (Feb. 1979) Stock No. 003-003-01697-1, $3.

Computer Science and Technology

Gray, M. M., Computer Science and Technology: Computers in the Federal Government: A Compilation of Statistics—1978, Nat. Bur. Stand. (U.S.), Spec. Publ. 500-46, 95 pages (Apr. 1979) Stock No. 003-003-02037-1, $2.75.

Warnar, R. B. J., Calomeris, P. J., and Recicar, S. A., Computer Science and Technology: Computer Peripheral Memory System Forecast, Nat. Bur. Stand. (U.S.), Spec Publ 500-45, 147 pages (Apr. 1979) Stock No. 003-003-02039-7, $3.25.

Health and Safety

Scott, W. W., Jr., Communication Systems Guide, Nat. Bur. Stand. (U.S.), Spec. Publ. 480-12, 36 pages (Jan. 1979) Stock No. 003-003-02012-5, $1.60.

Electronic Technology

Koyama, R. Y., and Buehler, M. G., Semiconductor Measurement Technology: A Wafer Chuck for Use Between —196 and 350 °C, Nat. Bur. Stand. (U.S.), Spec. Publ. 400-55, 24 pages (Jan. 1979) Stock No. 003-003-02017-6, $1.20.

Gilsinn, D., and Kraft, R., Semiconductor Measurement Technology; DISTRIB I, An Impurity Redistribution Computer Program, Nat. Bur. Stand. (U.S.), Spec. Publ. 400-57, 130 pages (Feb. 1979) Stock No. 003-003-02030-3, $3.

Engineering, Product and Information Standards

McEwen, H., Representations of Local Time of the Day for Information Interchange, Nat. Bur. Stand. (U.S.), Fed. Info. Process. Stand. Publ. (FIPS PUB) 58, 4 pages (Feb. 1979).

McEwen, H., Representations of Universal Time, Local Time Differentials, and United States Time Zone References for Information Interchange, Nat. Bur. Stand. (U.S.), Fed. Info. Process. Stand. Publ. (FIPS PUB) 59, 4 pages (Feb. 1979).

Lasers and Their Applications

Johnson, E. G., Jr., Laser Beam Profile Measurements Using Spatial Sampling, Fourier Optics, and Holography, Nat. Bur. Stand. (U.S.), Tech. Note 1009, 96 pages (Jan. 1979) Stock No. 003-003-02019-2, $2.75.

Young, M., and Lawton, R. A., Measurement of Pulsed-Laser Power, Nat. Bur. Stand. (U.S.), Tech. Note 1010, 40 pages (Feb. 1979) Stock No. 003-003-02028-1, $1.60.

Mathematical and Statistical Methods

Evans, R. J., Non-Free Groups Generated by Two Parabolic Matrices, J. Res. Nat. Bur. Stand. (U.S.), *84*, No. 2, 179-180 (Mar.-Apr. 1979)

Metrology: Physical Measurements

Croarkin, C., Beers, J., and Tucker, C., Measurement Assurance for Gage Blocks, Nat. Bur. Stand. (U.S.), Monogr. 163, 78 pages (Feb. 1979) Stock No. 003-003-02023-1, $2.50.

Wylie, R. G., Psychometric Wet Elements as a Basic for Precise Physico-Chemical Measurements, J. Res. Nat. Bur. Stand. (U.S.), *84*, No. 161-177 (Mar.-Apr. 1979).

Properties of Materials: Electronic, Magnetic, and Optical

Feldman, A., Horowitz, D., Waxler, R. M., and Dodge, M. J., Optical Materials Characterization—Final Technical Report, February 1, 1978-September 30, 1978, Nat. Bur. Stand. (U.S.), Tech. Note 993, 71 pages (Feb. 1979) Stock No. 003-003-02031-1, $2.40.

Standard Reference Data

Bauer, A., Boucher, D., Burie, J., Demaison, J., and Dubrulle, A., Microwave Spectra of Molecules of Astrophysical Interest. XV. Propyne, J. Phys. Chem. Ref. Data *8*, No. 2, 537-558 (1979).

Chen, S. S., Kudchadker, and Wilhoit, R. C., Thermodynamic Properties of Normal and Dueterated Naphthalenes, J. Phys. Chem. Ref. Data *8*, No. 2, 527-536 (1979).

Chi, T. C., Electrical Resistivity of Alkali Elements, J. Phys. Chem. Ref. Data *8*, No. 2, 339-438 (1979).

Chi, T. C., Electrical Resistivity of Alkaline Earth Elements, J. Phys. Chem. Ref. Data *8*, No. 2, 439-498 (1979).

Holland, P. M., and Hanley, H. J. M., A Correlation of the Viscosity and Thermal Conductivity Data of Gaseous and Liquid Propane, J. Phys. Chem. Ref. Data *8*, No. 2, 559-576 (1979).

Krause, M. O., Atomic Radiative and Radiationless Yields for *K* and *L* Shells, J. Phys. Chem. Ref. Data *8*, No. 2, 307-328 (1979).

Krause, M. A., and Oliver, J. H., National Widths of Atomic *K* and *L* Levels, *Kα* X-Ray Lines and Several *KLL* Auger Lines, J. Phys. Chem. Ref. Data *8*, No. 2, 329-338 (1979).

Kudchadker, A. P., Kudchadker, S. A., Shukla, R. P., and Patnaik, P. R., Vapor Pressures and Boiling Points of Selected Halomethanes, J. Phys. Chem. Ref. Data *8*, No. 2, 499-518 (1979).

Kudchadker, S. A., and Kudchadker, A. P., Ideal Gas Thermodynamic Properties of Selected Bromoethanes and Iodoethane, J. Phys. Chem. Ref. Data *8*, No. 2, 519-526 (1979).

Thermodynamics and Chemical Kinetics

Goodwin, R. D., Modification of the Nonanalytic Equation of State for the Limit of Low Densities, J. Res. Nat. Bur. Stand. (U.S.), *83*, No. 4, 325-327 (July-Aug. 1978).

Goodwin, R. D., Specific Heats of Saturated and Compressed Liquid Propane, J. Res. Nat. Bur. Stand. (U.S.), *83*, No. 5, 449-458 (Sept.-Oct. 1978).

Kilday, M. V., Enthalpies of Solution of Nucleic Acid Bases 1. Adenine in Water, J. Res. Nat. Bur. Stand. (U.S.), *83*, No. 4, 347-370 (July-Aug 1978).

Kilday, M. V., Enthalpies of Solution of Nucleic Acid Bases. 2. Thymine in Water, J. Res. Nat. Bur. Stand. (U.S.), *83*, No. 6, 529-537 (Nov.-Dec. 1978).

Smith-Magowan, D., Goldberg, R. N., A. Bibliography of Sources of Experimental Data Leading to Thermal Properties of Binary Aqueous Electrolyte Solutions, Nat. Bur. Stand (U.S.), Spec. Publ. 537, 89 pages (Mar. 1979) Stock No. 003-003-02033-8, $2.75.

Technology Incentives

King, M. H., Ed., Footwear Technology Symposium—Manufacturing a Competitive Advantage. Proceedings of the Footwear Technology Symposium held at the National Bureau of Standards, Gaithersburg, MD, June 1-2, 1978, Nat. Bur. Stand. (U.S.), Spec. Publ. 527, 348 pages (Feb. 1979) Stock No. 003-003-02025-7, $5.50

Other Subjects of General Interest

Weber, S. F., Historic Preservation Incentives of the 1976 Tax Reform Act: An Economic Analysis, Nat. Bur. Stand. (U.S.), Tech. Note 980, 32 pages (Feb. 1979) Stock No. C03-003-02015-0, $1.50.

NEWS BRIEFS

WHAT MAKES ARSONISTS TICK? Typical characteristics of arsonists and the existing literature on the psychology of firesetters are reviewed in a new report sponsored by the NBS Center for Fire Research. The Psychology of Firesetting: A Review and Appraisal, by two University of North Carolina researchers, summarizes what is known about arsonists and what we still fail to understand. A new approach for categorizing arsonists is presented. Paperback, 58 pages, National Technical Information Service, Springfield, VA 22151, $5.25. Order by number PB 290-821.

OIL RECYCLING. Measurement methods and standards for recycled oil used as automobile crankcase oil will be the primary topic of a conference on Measurements and Standards for Recycled Oil/Systems Performance and Durability to be held at NBS, Gaithersburg, MD, October 23-26. The conference is sponsored by NBS, the Mechanical Failures Prevention Group, and ASTM Technical Division P on Recycled Petroleum Products and Lubricants. The conference will consist of invited lectures by experts in petroleum testing and evaluation, systems performance, and materials durability.

TIME AND FREQUENCY SEMINAR. Engineers and technicians involved in making time or frequency measurements and calibrations are invited to attend a seminar conducted by NBS in Boulder, Colorado, on August 29-30. For application forms and lodging information, contact Sandy Howe, Time and Frequency Division, National Bureau of Standards, Boulder, Colo. 80303, telephone 303/499-1000, ext. 3212 or 3282. For additional technical information, call George Kamas, 303/499-1000, ext. 3378. Registration deadline is August 1, 1979.

BUILDING TECHNOLOGY RESEARCH. An overview of the activities under way at the NBS Center for Building Technology (CBT) is now available in a 21-page booklet. Center for Building Technology: A Perspective--1979 is NBS Special Publication 439-1 and can be ordered from the U.S. GPO, Wash., D.C. 20402, SD Stock No. 003-003-02056-7, $1.40.

COMPUTERIZED SITE SECURITY SYSTEM. Storage site protection for nuclear weapons and materials is the subject of an ongoing design study by NBS for the Defense Nuclear Agency. The second phase of the study was recently completed and details are reported in Phase II Final Report, Computerized Site Security Monitor and Response System NBSIR 79-1725. Paperback, 117 pages, available from National Technical Information Service, Springfield, VA 22161, PB 294 343, $6.50.

NEXT MONTH IN

DIMENSIONS NBS

Without the use of preservation techniques, historic adobe buildings in the Southwest deteriorate through erosion from rain and ground water seepage. Read how microwave technology can be used to help protect these structures in the next issue of DIMENSIONS/NBS.

U.S. DEPARTMENT OF COMMERCE
Juanita M. Kreps, Secretary

Jordan J. Baruch, Assistant Secretary for Science and Technology

NATIONAL BUREAU OF STANDARDS
Ernest Ambler, Director

Prepared by the Public Information Division
Washington, D.C. 20234

Richard S. Franzen, Chief

Madeleine Jacobs, Chief, Media Liaison and General Publications

Juli Chappell, Editor

Gail Porter, Associate Editor

Justine A. Williams, Assistant Editor

Stan Lichtenstein, Production Manager

Skip Wenner, Visual Editor
(Commerce Department)

PHOTO CREDITS

Cover photo courtesy of NASA.
Mark Helfer: Page 5, flush left.
National Fire Protection Association, page 5.

The Commerce Department's National Bureau of Standards was established by Congress in 1901 to advance the Nation's science and technology and to promote their application for public benefit. NBS research projects and technical services are carried out by the National Measurement Laboratory, the National Engineering Laboratory, and the Institute for Computer Sciences and Technology. Manufacturing, commerce, science, government, and education are principal beneficiaries of NBS work in the fields of scientific research, test method developments, and standards writing. DIMENSIONS/NBS describes the work of NBS and related issues and activities in areas of national concern such as energy conservation, fire safety, computer applications, materials utilization, and consumer product safety and performance. The views expressed by authors do not necessarily reflect policy of the National Bureau of Standards or the Department of Commerce.

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Annual subscription: Domestic, $11.00, foreign, $13.75. Single copy: Domestic, $1.10, foreign, $1.40. The Secretary of Commerce has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this periodical has been approved by the Director of the Office of Management and Budget through June 30, 1981.

AN EQUAL OPPORTUNITY EMPLOYER

U.S. DEPARTMENT OF COMMERCE
National Bureau of Standards
Washington, D.C. 20234

OFFICIAL BUSINESS
Penalty for Private Use, $300
RETURN POSTAGE GUARANTEED

POSTAGE AND FEES PAID
U.S. DEPARTMENT OF COMMERCE
COM-215

U.S.MAIL

CONTROLLED CIRCULATION RATE

DNBS SERIA300SEISSDUE006R I
SERIALS PROCESSING
UNIVERSITY MICROFILMS INTL
300 N ZEEB RD
ANN ARBOR MI 48106